SECTION 1: Identification of the substance/mixture and of the company/undertaking

1.1 Product identifiers

Product name: Cellulose Nanofibers (CNF)

Other common names or synonyms: cellulose nanofibrils, microfibrillated cellulose, nanofibrils, microfibrils, nanofibrillated cellulose, cellulose nanofibers

CAS no: 9004-34-6 (Cellulose, manufactured nanofibril form)

REACH no.: At present, REACH does not require registration of cellulose nanomaterials. Cellulose pulp is exempt from Registration according to the provisions of Article 2(7)(a) and Annex IV of REACH.

EC No: 232-674-9 (Cellulose)

1.2 Relevant identified uses of the substance or mixture and uses advised against

Relevant identified uses: Manufacture of substances, laboratory chemicals, inclusion in paper and paperboard products, coatings

Uses advised against: None

1.3 Details of the Supplier of the Safety Data Sheet

Company: University of Maine
Address: 5737 Jenness Hall
Phone number: 207-581-2281
Fax: 207-581-4174
E-mail: umaine.pdc@maine.edu

1.4 Emergency telephone number

Emergency phone number: 207-5814045 (UMaine Safety & Environmental Management)

SECTION 2: Hazards identification

2.1 Classification of the substance or mixture

Classification according to Regulation (EC) No. 1272/2008 [CLP]; ***if dried or powder form:***
STOT SE 3 (H335: May cause respiratory irritation)

2.2 Label elements

Labelling according to Regulation (EC) No 1272/2008 [CLP]

Hazard pictogram: GHS07: Exclamation mark

Signal word*:* WARNING

Hazard statements

H335: May cause respiratory irritation (if in powder form)

Precautionary statements

Precautionary statements – prevention

P210: If dry, keep away from all ignition sources including heat, sparks, open flames. Prevent dust accumulations to minimize explosion hazard.
P261: Avoid breathing dust
P262: Do not get in eyes, on skin, or on clothing
P271: Use only outdoors or in a well-ventilated area
P280: Wear protective gloves/protective clothing/eye protection/face protection

Precautionary statements – response

P304+P340: IF INHALED Remove victim to fresh air and keep at rest in a position comfortable for breathing.
P305+P351+P338: IF IN EYES Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P312: Call a POISON CENTER or doctor/physician if you feel unwell.
Precautionary statements – disposal
P501: Dispose of contents/container in accordance with local/regional/national/international regulation.
Supplemental Hazard information (EU): not applicable

2.3 Other hazards

Explosion hazard: Strong explosion hazard if dust is dispersed into air at high enough concentrations. *
*if powder form

SECTION 3: Composition/information on ingredients

3.1 Substances OR 3.2 Mixtures

Chemical name: Cellulose Nanofibrils
CAS no: 9004-34-6 (Cellulose, manufactured nanofibril form)
Composition:

Material	CAS Number	EINECS Number	Weight %	Agency	Exposure Limits	Comments
Natural Cellulose Fiber	9004-34-6	265-998-8	2-98	OSHA OSHA ACGIH	15 mg/m^3 5 mg/m^3 10 mg/m^3	PEL Total dust PEL Respirable dust TLV Total dust
Water	N/A	N/A	98-2		N/A	N/A

SECTION 4: Description of first aid measures

4.1 First aid measures	***Inhalation***	If dry powder, move to fresh air. Get medical attention if symptoms appear.
	Skin contact	Soap wash. Get medical attention if irritation occurs.
	Eye contact	Remove any contact lenses. Irrigate immediately. Get medical attention if irritation occurs.
	Ingestion	Do not induce vomiting unless directed to do so by medical personnel. Get medical attention if symptoms appear.
4.2 Most important symptoms and effects, both acute and delayed	***Acute effects***	Potential symptoms: Hoarseness, cough and phlegm. Exercise-induced dyspnea.
	Delayed effects	No data available.
4.3 Indication of any immediate medical attention and special treatment needed	***Note to physician***	This product may contain nanoscale particles. At this time, there is no further guidance specific to nanomaterial exposure.

SECTION 5: Firefighting measures

5.1 Extinguishing media	Use water, alcohol-resistant foam, dry chemical, or carbon dioxide.
5.2 Special hazards arising from the substance or mixture	**Explosion**: If powder, avoid generating dust.
5.3 Advice for fire fighters	As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective clothing.

SECTION 6: Accidental release measures

6.1 Personal precautions, protective equipment and emergency procedures	For dry powders, remove ignition sources and provide sufficient ventilation. Avoid dispersal of powder in air (i.e. clearing with compressed air), use current good practices. If powder, wear full set of protective clothing and contained breathing apparatus for spills, avoid inhalation, and wash skin following contact. See section 8 for more details on protective equipment.
6.2 Environmental precautions	In the case of accidental spill, keep away from drains, surface, and ground water. No acute environmental hazard.
6.3 Methods and materials for containment and cleaning up	For dry powders, ensure the product is not present at concentration level above cellulose TLV (section 8.1). Use HEPA-filtered vacuum or wet wiping methods and avoid re-dispersion of nanomaterial powder into the air. For gel spills, use absorbent materials/liquid traps. Immediately dispose of cleaning materials and do not dry and re-use contaminated materials.

SECTION 7: Handling and storage

7.1 Precautions for safe handling	If power form, the same precautions taken for handling and storage of dusts and fine powders should be implemented.
7.2 Conditions for safe storage, including any compatibilities	Store in closed, tightly sealed containers in cool (4°C), dry, well-ventilated area, away from sources of ignition, electrostatic sparks, extreme heat, or mechanical friction. Prevent gels from drying to powder. Protect from freezing. Do not store food or beverages in areas where materials are handled. Do not smoke in work area where nanomaterials are stored.

SECTION 8: Exposure controls/personal protection

8.1 Control parameters	
CNF	**Cellulose dust**
Gels do not represent an inhalation hazard; avoid inhalation exposure to if dried/powder forms and dusts. No exposure limits for nano-forms of cellulose. British Standards Institute has developed pragmatic guidance for OEL - for insoluble nanomaterials a factor of 0.066*OEL of micro-sized bulk material is proposed.	*OSHA PEL* - 15 mg/m^3 (total dust); 5 mg/m^3 (respirable fraction) TWA *NIOSH REL* – 10 mg/m^3 (total dust) TWA; 5 mg/m^3 (respirable fraction) TWA *American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV)* - 10 mg/m^3 TWA European country specific exposure limits ** *Belgium Limit Value (8h)* – 10 mg/m^3 *United Kingdom* – 10 mg/m^3 (total dust) TWA, 20 mg/m^3 (total dust) STEL; 4 mg/m^3 (respirable)
8.2 Exposure controls	
8.2.1 Engineering controls*:* If working with a powdered form or operations generate dust, fume, or mist, use ventilation to keep exposure to airborne contaminants below the exposure limit. Assess the most likely route of exposure and minimize risk. Refer to section 4.2.8.1 of ISO/TR 13329 for more information.	
8.2.2 Personal protection equipment*:* At present, due to a lack of nanomaterial-specific data regarding PPE, good hygiene practices are recommended. For gel, dermal exposure is possible and gloves, protective clothing, and goggles are recommended. If powder, in the absence of confirmatory measurements, inhalation exposure to dry forms should be avoided through the use of appropriate respirators. See Guidance at: http://www.cdc.gov/niosh/topics/nanotech/pubs.html .	
Gloves	Preliminary evidence suggests that butyl rubber gloves may be more protective than nitrile gloves. Regular disposal and replacement of gloves is recommended.
Protective Clothing	Cover skin to minimize dermal exposure, avoid direct contact with abraded or lacerated skin. Non-woven protective clothing is preferable to woven fabric laboratory coats. Prolonged use or reuse should be avoided.
Respirators and filters	If in powder form, limit dispersion of powder into the air, minimizing handling of powders, contain operations for handling powders, and working with proper exhaust ventilation with HEPA filters is recommended.

SECTION 9: Physical and chemical properties

9.1 Information on basic physical and chemical properties	**9.2** Particle **-specific properties** **NOT REQUIRED BUT BEST PRACTICE (ISO TR 13329)**
Appearance: Powder or gel, white or off-white. Solid (nanomaterial). ***Odor:*** Odorless ***Odor threshold:*** n/a ***pH:*** 7 ***Melting point/freezing point:*** n/a ***Initial boiling point and boiling range:*** n/a	***Particle core size:*** 5-200 nm width and 130nm to 225µm length. ***Particle size distribution:*** **5** nm - 200 nm ***Agglomeration/aggregation state*:** no data available ***Shape and aspect ratio:*** Fiber-like, and aspect ratio of 14-23. ***Specific surface area:*** no data available

Flash point: No data available for UMaine CNF. Cellulose ca. 240°C ***Evaporation rate:*** n/a ***Flammability (solid, gas):*** No data available for UMaine CNF. Cellulose may be combustible at high temperature (240°C) ***Upper/lower flammability or explosive limits:*** No data for UMaine CNF. Cellulose dust explosion class "St 2 – strong explosion". Cellulose dust deflagration index Kst = 229. ***Vapor pressure*:** n/a ***Vapor density*:** n/a ***Relative density:*** no data available ***Water Solubility:*** Insoluble; forms a gel ***Partition coefficient: n-octanol/water*:** No data. ***Auto-ignition temperature:*** No data available for UMaine CNF. Cellulose may self-ignite at high temperatures (ca. 240°C). ***Decomposition temperature:*** >349°C ***Viscosity:*** no data available ***Oxidizing properties:*** no data available	***Surface chemistry/elemental composition:*** no data available ***Surface charge (zeta potential):*** -48 to -5 mV ***Dustiness:*** no data available ***Crystallinity*:** 67-88%.

SECTION 10: Stability and reactivity

10.1 Reactivity
Cellulose is stable.

Cellulose dust is classified as "*St 2 – risk of strong explosion*", due to dust deflagration index Kst = 229 (OSHA CPL 03-00-008). At present, no data available for nanoscale cellulose.
10.2 Chemical stability: Thermal stability up to approx. 305°C (Stefaniak et al. 2014).
10.3 Possibility of hazardous reactions: No data for CNF. Cellulose is slightly flammable to flammable in presence of open flames and sparks, and non-flammable in the presence of shocks. Self-ignition may occur at high temperatures (240°C).
10.4 Conditions to avoid: For dust: high temperatures, extreme pressure, electrostatic sparks, collisions, mechanical friction.
10.5 Incompatible materials: No data for UMaine CNF. Fire and explosions may occur from reactions involving pentafluoride, acetic acid and micro crystalline cellulose. Contact between cellulose and sodium nitrite at elevated temperatures results in vigorous burning from decomposition reaction.
10.6 Hazardous decomposition products: No known hazardous decomposition products.

SECTION 11: Toxicological information

NOTE: where available, data reported for CNF. Where not, rely on studies with cellulose.
11.1 Information on toxicological effects
11.1.1 Likely routes of exposure
If in powder form: inhalation, eye; If a gel: dermal.
11.1.2 Immediate, delayed, or chronic effects

SHORT TERM EXPOSURE

	CNF	Cellulose
Inhalation	Data are limited; dust may be harmful if inhaled. A study in mice reported acute immune response in the lung following exposure to CNF, however also potential exposure to biocide (Vartiainen 2011).	May be harmful if inhaled. An *in vivo* rat study showed intratracheal exposure to high concentrations ("dust overload conditions") may lead to long term effects such as lung lesions (Muhle 1997). Exposure to lower concentrations or subchronic inhalation may result in acute inflammatory lung effects, which resolve after 30 days (Cullen 2000; Nagato 2008).
Ingestion	No data available.*	Acute exposure to Cellan 300 in rats found LOEC >3160 mg/kg (unpublished report, WHO 1998). LD50 > 5 g/kg for cellulose (RTECS MSDS).
Dermal contact	No data available.*	One study reported no dermal irritation after acute exposure up to 2000 mg/kg of microcrystalline cellulose (WHO 1998).
Eye contact	No data available.*	One study with MCC reported minimal irritation after acute ocular instillation in rabbit (WHO 1998).

LONG TERM EXPOSURE

	CNF	Cellulose
Inhalation	No data available.**	Occupational studies have shown long term exposure to dust and fibers in a factory setting (>10 mg/m^3) may lead to decreased lung function (not able to determine specific effect of cellulose) (Kraus 2004).
Ingestion	No data available.**	No adverse effects in rats consuming a 30% MCC diet for 72 days (unpublished report, WHO 1998). 0-20% cellulose diet 4 weeks in rat - no death nor growth effects (Hove 1978). 5, 10, 20% cellulose diet 21-days in rats - no death (Sundaravelli 1971). 10% MCC fed to rats for 35 weeks - no effects (Lupton 1988).
Dermal contact	No data available.**	No data available.**
Eye contact	No data available.**	No data available.**

11.1.3 Other measures of toxicity

	CNF	Cellulose
Immunotoxicity	Based on in vitro tests, no effect on cytokine or chemokine production >300 mg/L CNF (Vartiainen 2011).	Exposure to lower concentrations or subchronic inhalation of cellulose may result in acute inflammatory lung effects, which resolve after 30 days (Cullen 2000; Nagato 2008).
Neurotoxicity	No data available.	No data available.
Genotoxicity	Highest tolerated dose >240 mg/L in bacterial Ames test; no mutagenicity (Pitkänen 2010).	Highest tolerated dose >2000 mg/L in bacterial Ames test (OECD 471); no mutagenicity (Pitkänen 2010).

	After pharyngeal aspiration of 200 µg/mouse, no effects after 24h nor 28d on marrow polychromatic erythrocytes (as determined by micronucleus assay) (Aimonen 2015). *in vitro* Beas2B human bronchial epithelial cells: no DNA strand breakage (>950 mg/L) nor chromosomal damage (1250 mg/L) Lindberg (2014)	*in vitro* Beas2B human bronchial epithelial cells: no DNA strand breakage (>950 mg/L) nor chromosomal damage (1250 mg/L) (Lindberg 2014). *in vitro* BEAS2B human bronchial epithelial cells (48h) - no micronucleus induction >100 mg/L (Catalán 2014).
Carcinogenicity	No data available.	Rats fed a 30% MCC diet for 72 weeks - no increase in tumorigenicity (unpublished report, WHO 1998).
Reproductive toxicity	No egg-laying effects in nematodes (*C.elegans*) up to 500 mg/L (Pitkänen 2014).	Rats fed MCC a 30% MCC diet for 72 weeks – no adverse reproductive effects (WHO 1998).
Biodurability/ Biopersistence	CNF (both TEMPO and homogenized) in artificial airway epithelial lining fluid using serum ultrafiltrate) did not degrade (as evidenced by unchanged crystalline structure) over 7 days (Stefaniak 2014).	Cellulose highly biopersistent. Half time of cellulose fiber clearance around 1000 days after 1 time intratracheal instillation of 2 mg (dust overload condition) in rats (Muhle 1997). After 7 days in lung fluid, MCC did not degrade (Seehra and Stefaniak 2013).

SECTION 12: Ecological information

12.1 Toxicity

Acute data

Zebrafish embryo	CNF-TEMPO (Forest Products Laboratory)	LOEC = ~ 2000 mg/L	Harper et al. 2015 (in press)
	CNF-homogenization (Forest Products Laboratory)	LOEC = 200 mg/L	Harper et al. 2015
	CNF-homogenization (Maine Pilot Plant)	No mortality up to 2000 mg/L	Harper et al. 2015
Bacteria (*V. fischeri)*	1250 mg/L CNF (mechanically produced)	9% fluorescence inhibition	Vartiainen et al. 2011
Algae (*C. vulgaris)*	1-100 mg/L CNF (chemically produced)	Decreased viability after 96h	Pereira et al. 2014

Chronic data

No data for CNF.

12.2 Persistence and biodegradability	No data for CNF. Cellulose fibers readily biodegradable: Using ISO 14855-1999 and EN 14046-2003, complete degradation by 25 days (Fernandes et al. 2011). Using EN14046 cellulose powder and Whatman cellulose paper were >60% after 28 days, and 82% and 69% after 65 days (Vikman et al. 2014).

	CNF readily biodegradable: Non-functionalized NFC >70% degraded by day 28, approx. 90% degraded by day 70 (under "controlled composting conditions") (SUNPAP 2012). Using EN 14046, >60% degradation of NFC-based products (concentrated NFC granules, paper with 1.5% NFC additive, NFC film) after 65 days – 76%, 95%, and 100%, respectively (Vikman et al. 2014).
12.3 Bioaccumulative potential	No data available.
12.4 Mobility in soil	No data available.
12.5 PBT and vPvB assessment	No data available.
12.6 Other adverse effects	No data available.

SECTION 13: Disposal considerations

13.1 Waste treatment methods

All components are derived from natural materials and not anticipated to require specific handling for disposal. Avoid dust generation upon disposal. Not specifically listed as a hazardous waste under the Resource Conservation and Recovery Act (RCRA). However, if waste exhibits one or more of the following characteristics: ignitability, corrosivity, reactivity, or toxicity as described by 40 CFR 261.21-24, then waste must be classified as hazardous. At present, no nano-specific regulations exist. Waste must be disposed of in accordance with federal, state, and local environmental control regulations.

SECTION 14: Transport information

14.1 UN number: None
14.2 UN proper shipping name: Not applicable
14.3 Transport hazard class: Not applicable
14.4 Packing group: Not applicable
14.5 Environmental hazards: Not classified as hazardous to the environment
14.6 Special precautions for user: No additional information available
14.7 Transport in bulk according to Annex II of MARPOL73/78 and the IBC code: Not applicable

Cellulose is not a DOT controlled material (United States). At present, no nano-specific regulations exist.

SECTION 15: Regulatory information

15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture

None for CNF. For related substances**, OSHA regulations:** See Section 8.

15.2 Chemical safety assessment: No chemical safety assessment has been carried out for this substance by the supplier.

SECTION 16: Other information

SDS preparation date: 10-28-2016
SDS last known revision date and changes made: Version 1, February, 2017
SDS prepared by: Vireo Advisors, LLC. P.O. Box 51368, Boston, MA 02205 USA www.VireoAdvisors.com
SDS revised by: Vireo Advisors, LLC. P.O. Box 51368, Boston, MA 02205 USA www.VireoAdvisors.com

Other comments:

Refer to NFPA 654, Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids, for safe handling.

See ISO TR 13329.

NFPA Rating (based on cellulose dust):

Health 1; Flammability 1; Reactivity 0; Special information 0

NOTE:

The information in the safety data sheet should be provided to all who will use, handle, store, transport or otherwise be exposed to this product. All information concerning this product and/or suggestions for handling and use contained herein are offered in good faith and are believed to be reliable as of the date of publication. No warranty is made regarding the accuracy of and/or sufficiency of such information. Nothing contained herein shall be construed as granting or extending any license under any patent. If the date on this document is more than three years old, call to ensure that this sheet is current.